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MANUFACTURERS OF CATHODE-RAY OSCILLOSCOPES

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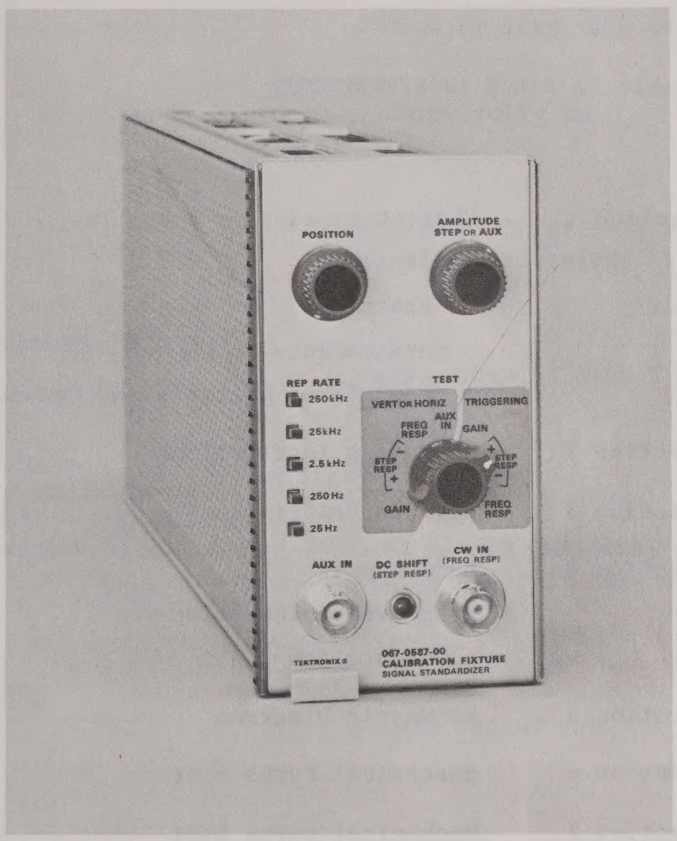
067-0587-00 CALIBRATION FIXTURE

Signal Standardizer



The 067-0587-00 Calibration Fixture is a calibration aid for all 7000-series mainframes. The unit is designed to standardize all mainframes to all 7-series plug-in units both vertical and horizontal. Test functions permit calibration of deflection factor, step response, DC shift of display channels, and trigger channels. Bandwidth measurements of mainframe alone can be made by applying a frequency standard to the CW IN connector. Calibration of time base units is accomplished by applying signal from time-mark generator to the AUX IN connector.

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SECTION 1
CHARACTERISTICS

Characteristics		Performance Requirement
		ELECTRICAL
VERT or HORIZ Mode		
STEP RESPONSE		
Risetime	RT	750 ps or less into display channel
Amplitude		At least 8 div of display with AMPLITUDE control fully cw
GAIN Steps		
Accuracy	Ga	Within 0.25% of calibration standard maintained at factory.
FREQUENCY RESPONSE (CW IN)		
Response	Ft	Flat within 3% with 3 MHz to 200 MHz sine-wave input
Input Impedance		$\approx$ 50 Ω
Auxiliary Input (AUX IN)		
Input Impedance		$\approx$ 15 Ω with AMPLITUDE control fully cw, $\approx$ 1 kΩ with AMPLITUDE control fully ccw
REPETITION RATE		
Accuracy		Within 50% of rate selected
TRIGGERING Mode		
STEP RESPONSE		
Risetime		1 ns or less into trigger channel
Amplitude		At least 8 div of display with AMPLITUDE control fully cw
GAIN Steps		
Accuracy		Within 0.25% of calibration standard maintained at factory

ELECTRICAL (cont)

FREQUENCY RESPONSE (CW IN)	
Response	Flat within 3% with 3 MHz to 200 MHz sinewave input
Input Impedance	≈ 50 Ω
REPETITION RATE	
Accuracy	Within 50% of rate selected

MECHANICAL

Characteristics	Requirement	Supplemental Information
Overall Dimensions		
Height	≈5 inches	
Width	≈2-5/8 inches	
Depth	≈14-1/8 inches	
Weight	≈1 pound	

ENVIRONMENTAL

Characteristics	Requirement	Supplemental Information
Temperature		
Operating Range	0°C to +50°C	Calibrated at 20°C to 30°C
Warmup Time	5 minutes at 25°C	

FRONT PANEL CONTROLS AND CONNECTORS

AMPLITUDE STEP OR AUX Control

Adjusts amplitude of + or + step or amplitude of signal applied to AUX IN connector.

POSITION Control

Positions display vertically or horizontally.

TEST Switch

VERT OR HORIZ

AUX IN

Displays signal applied to AUX IN connector.

FREQ RESP

Displays signal applied to CW IN connector.

- STEP RESP

Displays negative-going step

+ STEP RESP

Displays positive-going step.

GAIN

Permits adjustment of vertical or horizontal deflection factors.

TRIGGERING

GAIN

Applies staircase waveform to trigger channel.

+ STEP RESP

Applies a positive-going step to trigger channel.

- STEP RESP

Applies a negative-going step to trigger channel.

FREQ RESP

Applies signal from CW IN connector to trigger channel.

SECTION 2

OPERATING INSTRUCTIONS

The following procedure describes the basic functions of the Signal Standardizer when operated in a 7000-Series Oscilloscope. Detailed information for calibrating or testing the oscilloscope is described in the Instruction Manual supplied with the Instrument.

The Signal Standardizer is installed in one of the vertical or horizontal channels of the oscilloscope. To measure the step response of the display channel or trigger channel, the TEST switch is set at the appropriate STEP RESP position, + or - polarity. In this mode of operation, a pulser circuit contained within the Signal Standardizer provides a series of fast-rising pulses for checking the risetime of the selected channel on screen. An AMPLITUDE control adjusts the display size and pushbuttons select the REP RATE desired. A DC SHIFT pushbutton functions in this mode of operation to check the oscilloscope amplifier for DC shift. When the button is pushed, a single trace appears on screen at a position determined by the AMPLITUDE setting of the pulse.

When the TEST switch is in one of the GAIN positions, the Signal Standardizer generates a series of amplitude steps for checking the gain of the display channels or trigger channel. At slow sweep speeds, with the time-base triggering set to free-run, the gain steps appear as solid lines across the screen. The position of these lines, in relationship to the graticule lines, is used to denote the gain. The lines are also used to check or set either vertical or horizontal linearity and geometry. The REP RATE of the gain-step signal can be selected, however the fastest rate is used for most applications.

The FREQ RESP positions of the TEST switch are used to measure the frequency response of the display channels or trigger channel on screen. In this mode of operation, external sinewaves are applied at the CW IN connector

on the front panel of the Signal Standardizer. A Tektronix Type 067-0532-01 Constant-Amplitude Signal Generator is recommended as a signal source for making the frequency response measurements.

The AUX IN position of the TEST switch is used to check horizontal timing and linearity of the oscilloscope. The Signal Standardizer is installed in a vertical channel, and a time-base unit installed in a horizontal channel, of the oscilloscope. A Time-Mark Generator such as a Tektronix Type 184 or 2901 is connected to the AUX IN connector on the front panel of the Signal Standardizer.

SECTION 3

CIRCUIT DESCRIPTION

PULSER

The pulser circuitry consists of a rep rate multi, one buffer stage, a driver stage, and a diode pulser stage. Pulse repetition rate is determined by REP RATE pushbuttons selecting on of five emitter coupled timing capacitors in the flip-flop multi consisting of Q105 and Q115. The output of Q105, Q115 flip-flop drives the buffer, Q144, Q154 pushpull. Current amplifier Q164, Q174 provide drive for diode switches CR182, CR183, and CR192, CR193. The combination of L162, C162, L163, L172, L173 provide preshoot compensation of both + step and - step. C183, and C193 compensate for differences in capacity in Shottky diodes. Pulse Ampl Bal R165 balances out any differences in diode forward resistance. R160A ganged with R160B and R160C permit up to 500 mV amplitude with adjustment of AMPLITUDE STEP OR AUX control. The emitter coupled comparator Q124, Q126 is driven from collector of Q105 of the multi. The output taken from the collector of Q125 provides a clock pulse for the staircase generator.

CW IN

The external sinewave signal is applied through the BNC front-panel connector to the primary of the current transformer T251. Two secondary windings provide the differential output to drive the vertical or horizontal input of the oscilloscope. The signal is routed through the TEST switch to either the signal or trigger channel. Compensation networks R253, C253, and R258, C258 maintain the flat response of the sinewave signal. A third secondary winding provides a trigger pick-off without loading the input.

AUX IN

The external auxiliary signal (normally the output from a time-mark generator) is applied through the BNC front-panel connector to the AMPLITUDE control where signal level is established. Diodes CR274, 275, 277 and 278 are used as overload protection. The signal is then routed through the TEST switch to the signal channel of either the vertical or horizontal input of the oscilloscope. A portion of the signal is picked off for internal triggering.

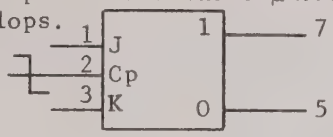
DC SHIFT

Pushing the DC SHIFT button S106 grounds the emitter of Q115, stopping the multivibrator Q105 - Q115. This in turn disables multivibrator Q164 - Q174, turning the switching diodes CR182, 183, 192, 193 on. This establishes an on-screen reference level at a position determined by the setting of the AMPLITUDE control.

GAIN STAIRSTEP CIRCUIT

Label the flip-flops 1-2-3-4 left to right, label the transistors Q1 to Q8 from top to bottom.

1. The flip-flops are Fairchild μL923's which are negative-edge-triggered J-K flip-flops.



Pin 1 -- J Input
Pin 2 -- Clock Input
Pin 3 -- K Input
Pin 5 -- "0" Output
Pin 7 -- "1" Output

2. It has this truth table; logic assignment is: negative logic --

	Pin 1 Input	Pin 3 Input	Pin 7 Output After Clock Pulse
a)	High	High	No change
b)	High	Low	High
c)	Low	High	Low
d)	Low	Low	Complements (Toggles)

The table entries

a) Output will not change state if triggered when inputs are both high or logic "zero".

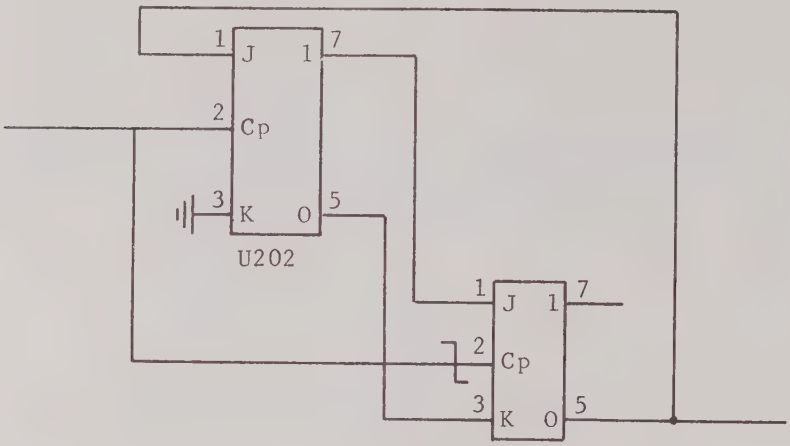
b)c) Past history of the voltage at the inputs will be reflected to the output. After clock trigger, the "1" output (pin 7) will be the same state as the input (J) pin 1 was prior to trigger. The inputs 1, 3 reflect to the outputs 7, 5 respectively.

d) The two inputs, both low or logic "1", are the flip-flop mode. If output pin 7 was high, after trigger it will be low, output pin 5 is always the complement of pin 7, being the opposite side of the bistable multivibrator. If the 923 has grounded J and K inputs (1 & 3) and it is continually triggered, this is a divide-by-two circuit of the trigger repetition rate.

3. The GAIN SET circuit contains two sets of 2 flip-flops connected in a particular way. The input clock of the first set is the Repetition Rate trigger waveform, the input clock of the second pair is the pin 7 output from the second of the first set of flip-flops.

Notice that U202 pin 3 (K input) is grounded ("LO"), and the outputs of U202 pins 5, 7 are to the inputs 3, 1 of U204.

Configuration of the pair of flip-flops:



923 J-K Truth Table

	1	3	7
a)	HI	HI	N.C.
b)	HI	LO	HI
c)	LO	HI	LO
d)	LO	LO	TOGGLE

Assuming the following, proceed through the states of the flip-flop as it receives several triggers.

Assume 1) U202 pin 5 is HI, pin 7 is LO.
2) U204 pin 5 is LO, pin 7 is HI.

then: U204 pin 5 if fed back to U202 pin 1, therefore U202 with the K input grounded has LO - LO as inputs. So on receiving the trigger, U202 will toggle; we assumed it had pin 5 HI, 7 LO. Following the trigger it is pin 5 LO, pin 7 HI as outputs.

The assumption that U202 had pin 5 HI, pin 7 LO furnishes the inputs of U204 with those voltage states. When the trigger comes, the inputs (previous histories) of U204 pin 1 and 3 are LO - HI respectively. At trigger, these inputs appear on the outputs; (J) pin 1 input appears on pin 7 ("1") output, likewise (K) pin 3 input appears on pin 5 ("0") output. See truth table.

A complete state chart can now be constructed, knowing the two types of behavior just explained with the arrows:

1. U202 toggles when U204 pin 5 is LO, on receiving a trigger (pin 2)
2. U204 remembers U202's previous history

also,

3. U204 pin 5 will furnish U202 pin 1 new feedback history, U202 will obey 1) or pin 7= HI when U204 pin 5 = HI, after the next trigger.

		U202		U204	
		5	7	5	7
START		HI	LO	LO	HI
(Triggers)	1	LO	HI	HI	LO
	2	LO	HI	LO	HI
	3	HI	LO	LO	HI
	4	The states in 3 above are the same as the START states, hence the cycle repeats.			

Now the complete circuit of 4 flip-flops can be understood: U202 - U204 and U206 - U208 each connected in similar manner. U202 - U204 get their clock pulsed from the repetition rate circuit, U206 - U208 get triggers from the output of U204 pin 7, triggering on negative going edges of that output. The rules above apply for both sets of flip-flops as a unit. A complete state chart appears like this:

		U202		U204		U206		U208	
Pin No:		5	7	5	7	5	7	5	7
START		L	H	L	H	L	H	L	H
Clock	1	H	L	L	H	L	H	L	H
	2	L	H	H	L	H	L	L	H
	3	L	H	L	H	H	L	L	H
	4	H	L	L	H	H	L	L	H
	5	L	H	H	L	L	H	H	L
	6	L	H	L	H	L	H	H	L
	7	H	L	L	H	L	H	H	L
	8	L	H	H	L	L	H	L	H
	9	L	H	L	H	L	H	L	H

...the cycle repeats

Now that the states of all the outputs are known, the remainder of the Gain Set circuits can be discussed. Note that each of the flip-flops' outputs go to the bases of transistors Q202 through Q224. Pins 5 connect to Q202 - Q208, the NPN's pin 7 connect to Q212-Q224 the PNP's through a bias network. Q202, 204, 220 and 224 have 98.80 kΩ as collector loads to their 50 volt (plus or minus) supply.

Q206, 208, 212, and 216 have 24.625 kΩ collector load to their +50 V or -50 V supplies. Each collector has a diode 152-0141-00 to connect it to an output summing line. Q202, 206, 212, 220 connect to the output B11 (- signal) interface. Q202, 208, 216, 224 connecto to form the output on A11 (+ signal). In the mainframe both A11 and B11 find approximately 50 ohm terminations. Depending upon the states of the flip-flops, the outputs, pins 5 and 7, will turn on or turn off their respective transistors. Q202 turns off Q202 when pin 5 is LO, also Q224 is off, because when pin 5 is LO, pin 7 is HI. When Q202 is off, it supplies +0.5 mA, (50 volts ÷ 99 kΩ) through the diode to the B11 (minus signal) line. Q224 off furnishes -0.5 mA through the diode to the A11 (plus signal) line. The supply and resistors of all OFF transistors contribute currents to A11, B11, the mainframe 50 ohm inputs. The order in which these currents change is the order in which the flip-flops are made to turn off their associated transistors. An expansion to the state chart will show which transistors are non-conducting (N) and will contribute currents to both A11 and B11 outputs.

A summary of the currents will show net current flowing into the mainframe 50 ohm inputs, and to a known deflection on the screen of the CRT.

Legend: L = Low, H = High, N = Non-conducting, C = Conducting.

For symmetry reasons, only the currents in one side need to be considered.

STATE CHART OF FLIP-FLOPS AND SUMMARY OF GAIN-SET CURRENTS:

	FLIP - FLOP NO.:								TRANSISTOR SWITCHES				A11 Net
U No.:	202		204		206		208		Q204	Q208	Q216	Q224	Current
Pin No.:	5	7	5	7	5	7	5	7	+0.5 mA	+2mA	-2mA	-0.5 mA	Into 50 Ω
START	L	H	L	H	L	H	L	H	N	N	N	N	0
Clock 1	H	L	L	H	L	H	L	H	N	N	N	C	+0.5 mA
2	L	H	H	L	H	L	L	H	C	N	C	N	+1.5 mA
3	L	H	L	H	H	L	L	H	N	N	C	N	+2 mA
4	H	L	L	H	H	L	L	H	N	N	C	C	+2.5 mA
5	L	H	H	L	L	H	H	L	C	C	N	N	-2.5 mA
6	L	H	L	H	L	H	H	L	N	C	N	N	-2 mA
7	H	L	L	H	L	H	H	L	N	C	N	C	-1.5 mA
8	L	H	H	L	L	H	L	H	C	N	N	N	-0.5 mA
9	L	H	L	H	L	H	L	H	N	N	N	N	0 mA

... the cycle repeats.

At clock No. 3 the conditions of Q204, 208, 216, 224 are N - N - C - N respectively, meaning that +0.5, -2, -0.5 mA are flowing out for a net +2 mA into the A11 50 ohm termination. Likewise, a net -2 mA flows into the B11 50 ohm termination, a 4 mA push-pull signal into 50 ohms gives 200 mV. On screen this is a deflection of 4 centimeters (@ 50 mV/cm push-pull).

The reconstructed waveform of the currents-turned-into-deflection-stair-steps as a function of time, beginning just as the state chart began, is:

DEFLECTION	
cm	Net mA
+5 div	+2.5
+4 div	+2
+3 div	+1.5
+1 div	+0.5
Center	0
-1 div	-0.5
-3 div	-1.5
-4 div	-2
-5 div	-2.5

At slower sweeps and with free-running triggers, the waveforms display the gain steps as solid lines across the screen. In a vertical plug-in compartment the vertical gain, linearity, and geometry are set and observed, the -5 div and +5 div deflections are off screen. In a horizontal time base plug-in compartment, the horizontal gain, linearity, and geometry can be set or observed. Here the -5 and +5 div deflection are seen at the 0 div and 10th lines of the graticule.

NOTES

SECTION 4
MAINTENANCE

CALIBRATION

EQUIPMENT REQUIRED

2 ~~GR~~ BNC to BNC Male (017-0064-00)

2 2 ns GR cables (017-0505-00)

2 50 Ω Terminations with ~~GR~~ BNC connectors (067-0515-00)

1 067-0589-00 Plug-in Extender

1 ~~Type 564B Storage Oscilloscope~~ 7A16A D04[illegible]

1 ~~Type 3S2 Plug-in~~ 7S11 D060[illegible]

2 ~~Type S-1 Sampling Heads~~ S6

1 ~~Type 3T2 Sampling Sweep~~ 7T11 D0509[illegible]

1 18" trigger cable with R658 BNC/BSM connector (012-0127-00)

2 GR 50 ohm Power T's (017-0082-00)

1 ~~Type 7A13 Plug-in~~ 7S14 D04

1 Type 7704 Oscilloscope or 7904 D0548[illegible]

1 ~~Type 7B70 Sweep~~ 7B92A D055133

1 Type 067-0532-01 Signal Generator or HPC 8640B

1 Digital Voltmeter Dynasciences Corp. Model DM440 W/DCmV option

1 Pushbutton Switch (260-0247-00)

1 Capacitor, 3.3 μF, +15 V (290-0246-00)

1 Tek 5S2 D0

1. Check plug-in connector pins for shorts. Set test function switch to STEP RESP +. Position control to mid range. Amplitude control to mid range.

   a. A18 - about 275 ohms

   b. A19 - about 20 k ohms

   c. A20 - 51 ohms

   d. B18 - about 375 ohms

   e. B19 - about 6 k ohms

f. Check between A2/A3 zero ohms

g. Check between B1/B2/B4/B5/B8/B9 for short

h. Check between A2/B2 for zero ohms

i. Check between A9/A14 for about 100 ohms

2. Position polarity.

Insert the plug-in extender into vertical plug-in compartment A of the Type 7704. Plug the type 067-0587-00 into plug-in extender. Set the Type 7704 power to ON. Set plug-in test switch to VERT or HORIZ GAIN. Check position polarity.

a. Position control CW. Trace moves up 0.5 div.

b. Check all vert or horiz positions for control. CW trace moves up.

3. Amplitude control polarity check.

Connect a cable between AUX IN and 1 kHz amplitude calibrator from 7704. Set amplitude calibrator to 4V.

a. Adjust amplitude control CW. Display should increase in amplitude.

b. Set plug-in test control to STEP RESP +. Adjust amplitude CW. Note pulse amplitude increased.

4. Check DC shift.

a. Push DC SHIFT and note no pulse amplitude on display when pushed.

5. Insert the plug-in extender into 7704 LEFT VERT compartment. Plug 067-0587-00 onto the extender. Set 067-0587-00 TEST switch to VERT or HORIZ GAIN.

   Left side rear

   a. Remove Q126 and connect single-shot pushbutton and 3.3 µF capacitor between collector pin of Q126 socket and gnd (See Fig. 1).

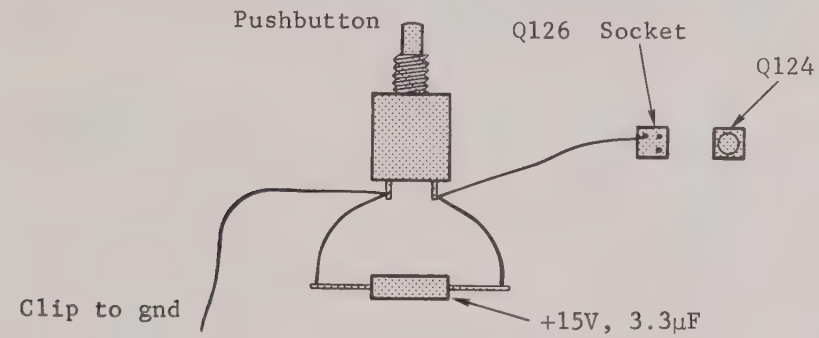


Fig. 1

   b. Connect extender pins A11 and B11 as shown in Fig. 2. Set Digital Voltmeter for mVDC. Term in precision 50 Ω resistn

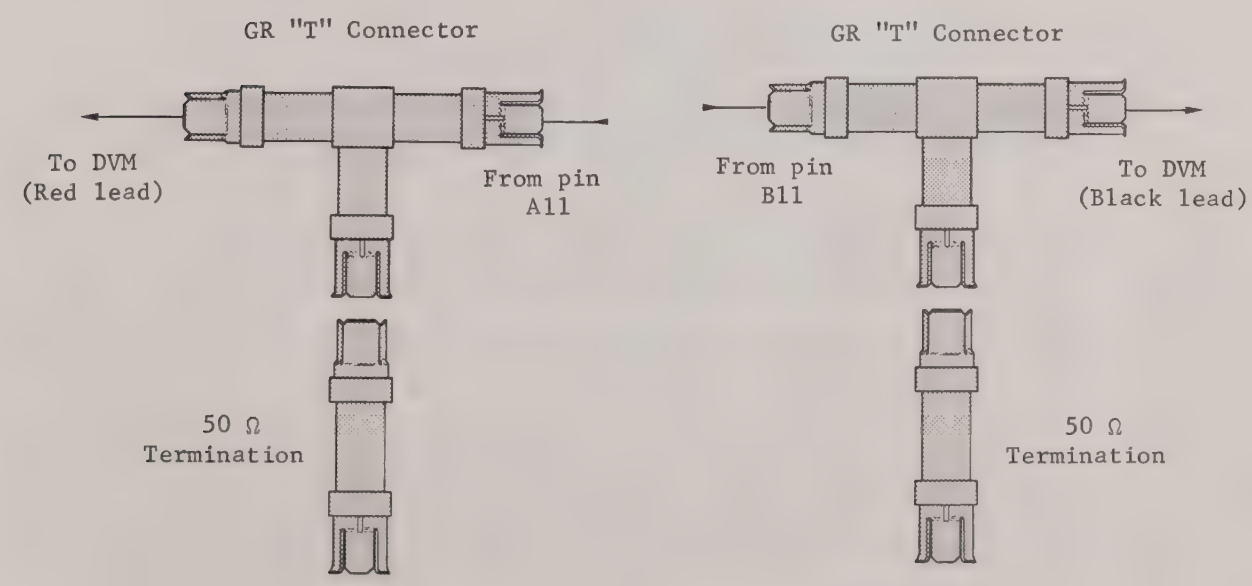


Fig. 2

c. Set 067-0587-00 POSITION to mechanical center. Press single-shot pushbutton until Digital Voltmeter indicates 0 mV. Adjust POSITION for less than + or - 0.050 mV.

d. Check GAIN accuracy at each of the steps in the following table. Press the single-shot pushbutton to change steps and note the Digital Voltmeter readout:

Step (mV)	Voltage Range (mV)
+250	+249.3 to +250.7
+200	+199.4 to +200.6
+150	+149.4 to +150.6
+50	+49.50 to +50.50
0	+0.050 to -0.50

e. Repeat for minus (-) mV steps.

6. Check trigger polarity and DC level. Change BNC connectors in plug-in extender A13 and B13 from extender to S1 Sampling Heads.
A13 to A input.
B13 to B input. B invert switch pulled out.
A and B input set to 50 mV..

a. Check amplitude pushpull output for 200 mV ±15%.

b. Check DC output level for 0 volts ±150 mV.

7. Check step response rep rate.
Set VERT OR HORIZ TEST switch to + step resp.

a. Check pulse rate for:

250 kHz ±50%

25 kHz ±50%

2.5 kHz ±50%

250 Hz ±50%

25 Hz ±50%

8. Check VERT OR HORIZ STEP RESP and risetime. Remove BNC connectors from S1 sampling plug-in and connect back to extender. Connect BNC cables from pins A11 and B11 to sampling heads.
   A11 to A input and B11 to B input.
   B input invert pushed in.
   (Note: Both sampling heads should be checked with a 284 Pulse Generator and 2 ns GR cables to check step response of sampling gear.)

   b. Adjust amplitude control for 3 div of signal, on A input.

   c. Adjust R165 for 3 div of signal on B input. Pull B input invert switch out.
      Set main function switch to A + B and check for 6 div of signal.

   d. Adjust C172 for flat start of pulse, on A input.

   e. Adjust C162 for flat start of pulse, on B input.

   f. Adjust C183 and 193 for flat corner response or to match 284 step response.
      Check aberrations 2± P-P. Risetime 750 ps or less. Check - step response.

9. Check frequency response.
   Set TEST VERT OR HORIZ switch to freq resp. Connect type 067-0532-01 Signal Generator sampling A input. Set sampling main switch to dual trace. Adjust signal for 3 div of signal on A sampling input, change signal generator to 300 MHz and note how far down the amplitude is down. Connect plug-in to sampling unit. Connect signal generator to CW input on test plug-in.

   a. Set 3 MHz amplitude for 3 div of signal. Change signal generator to 300 MHz, and adjust C258 for same amplitude as seen with sampling plug-in and signal generator, on A input.

   b. Adjust C253 for same amplitude on B input as seen on A input.

10. Check step response on triggering output.

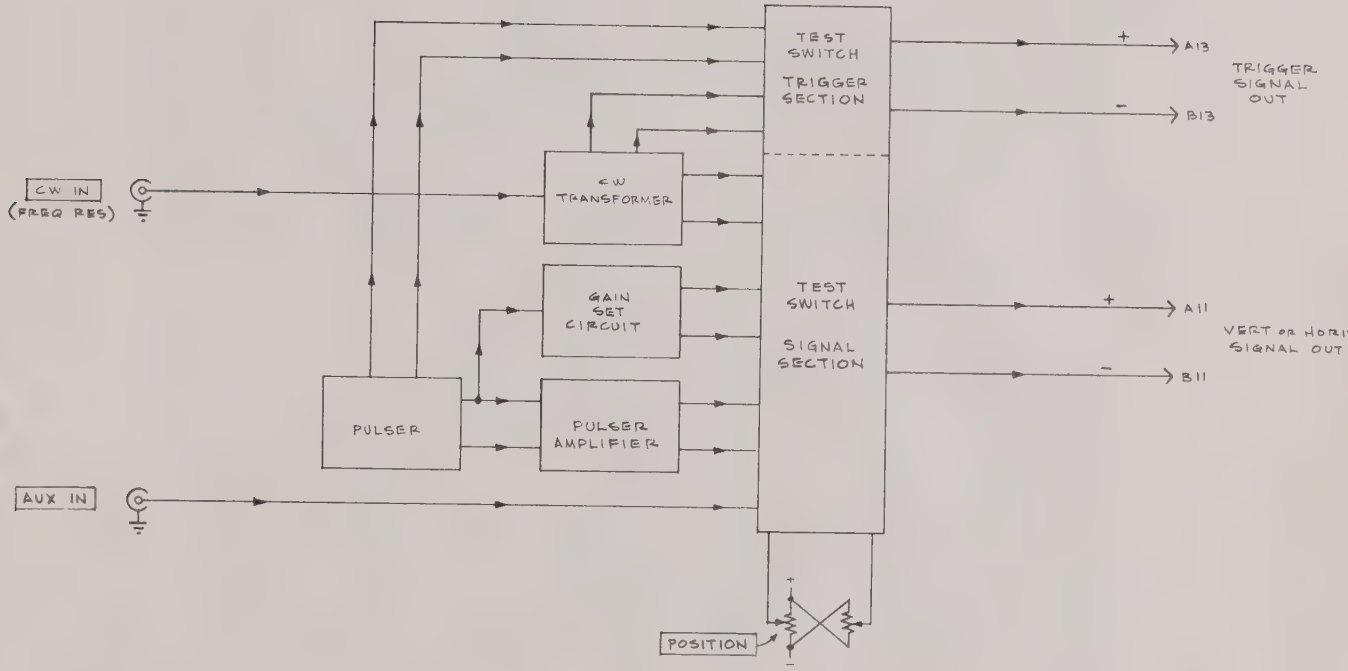
   a. Connect A13 and B13 to sampling plug-in, A13 to A input and B13 to B input. Check risetime. 750 ps. Aberrations 5% P-P. Check - STEP RESPONSE.

   b. Check CW bandpass.
      Connect 067-0532-01 to CW input and check frequency response. Check for flatness, 300 MHz ±3% from vertical response.

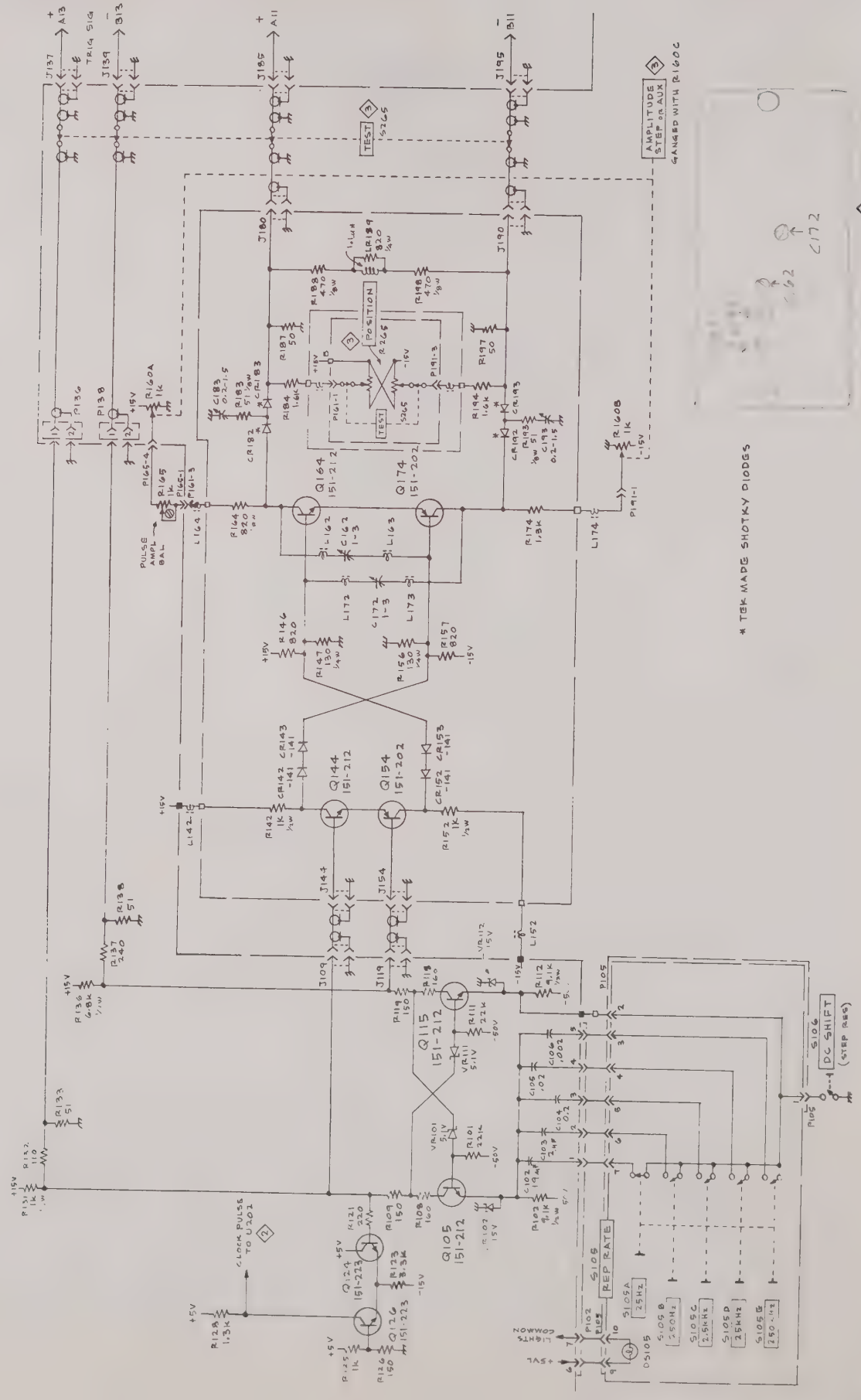
   c. Check gain steps.
      Change extender from A11 and B11 vertical input to scope, and connect A13 and B13 in 7704 vertical and check gain steps as in Step 5.

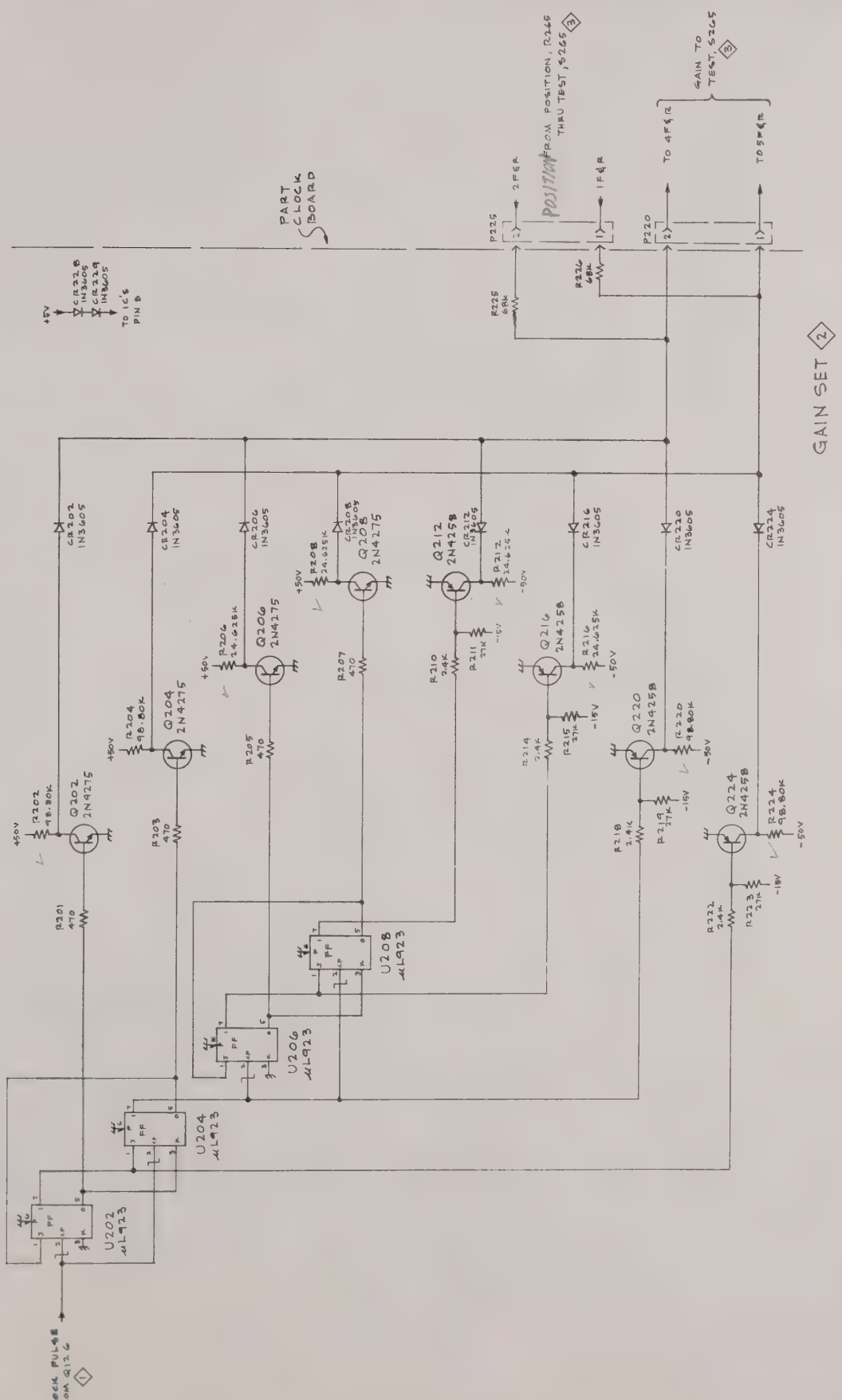
NOTES

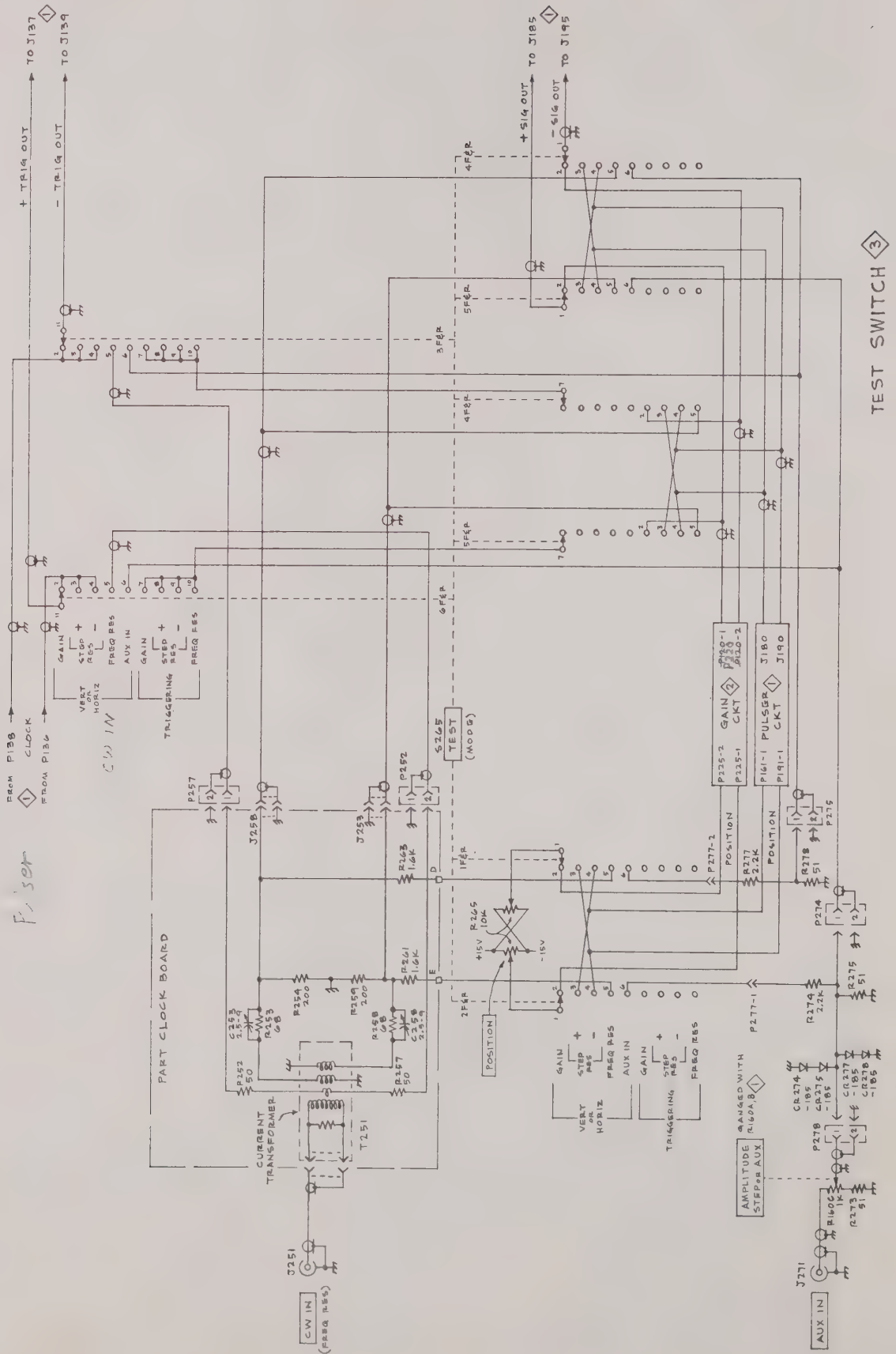
SECTION 5
SCHEMATIC DIAGRAMS

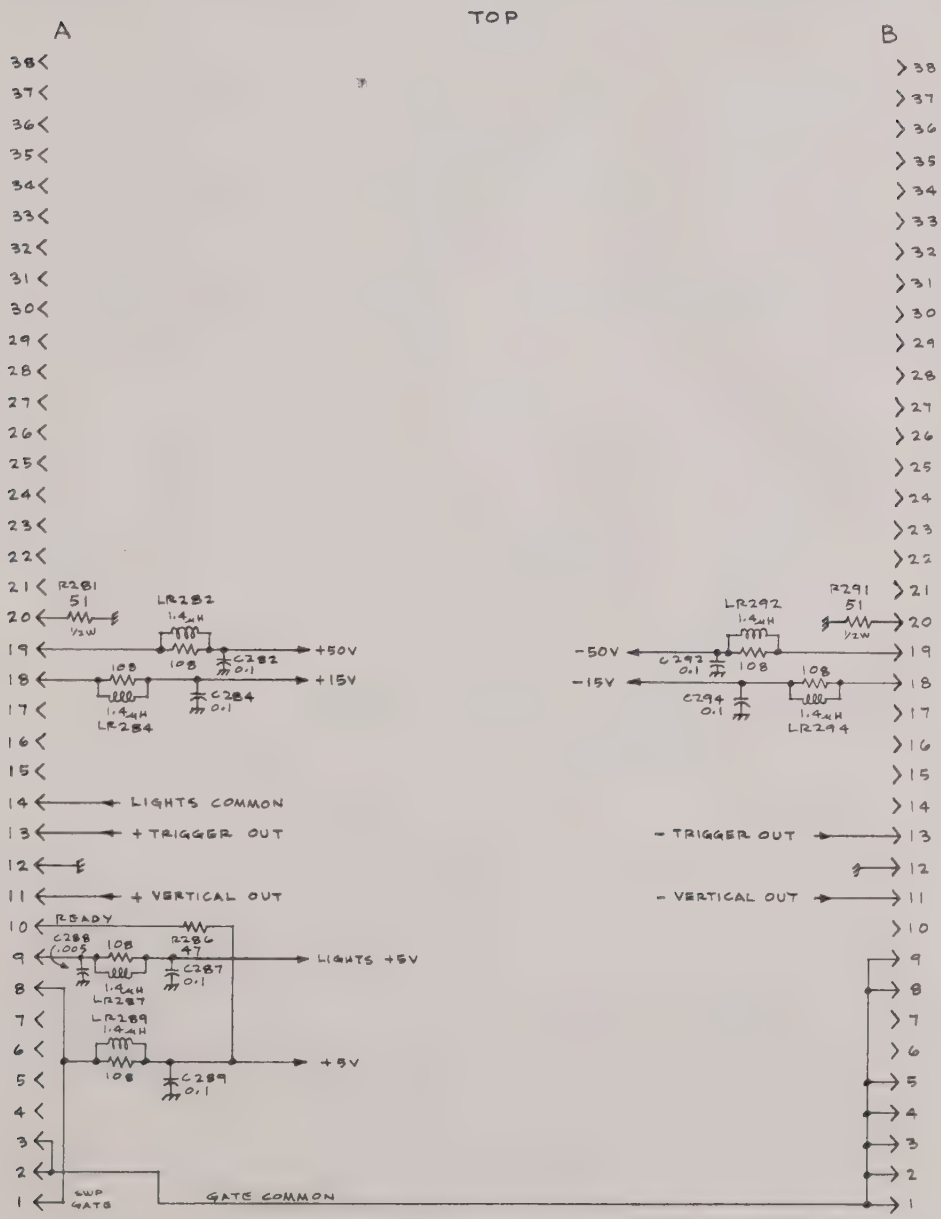


BLOCK DIAGRAM


PULSER
* TEK MADE SHOTKY DIODES
Q115 151-212
Q105 151-212
Q124 151-223
Q126 151-223
Q144 151-212
Q154 151-202
Q164 151-212
Q174 151-202
S105 REP RATE
S106 DC SHIFT
(STEP RES)
CLOCK PULSE TO U202
PULSE AMPL BAL
TEST
POSITION
AMPLITUDE STEP ON AUX
GANGED WITH R160C


GAIN SET 2
PART CLOCK BOARD
POSITION FROM POSITION, R265 THRU TEST, S265
GAIN TO TEST, S265
TO 4FQR
TO 5FQR
1FQR
2FQR
P225
P220
R225 68K
R226 68K
+5V
CR226 IN3605
CR228 IN3605
CR229 IN3605
TO IC'S PIN 8
CR202 IN3605
CR204 IN3605
CR206 IN3605
CR208 IN3605
CR212 IN3605
CR216 IN3605
CR220 IN3605
CR224 IN3605
Q202 2N4275
Q204 2N4275
Q206 2N4275
Q208 2N4275
Q212 2N4258
Q216 2N4258
Q220 2N4258
Q224 2N4258
R202 98.80K
R204 98.80K
R206 24.625K
R208 24.625K
R212 24.625K
R216 24.625K
R220 98.80K
R224 98.80K
R201 470
R203 470
R205 470
R207 470
R210 2.4K
R211 27K
R214 2.4K
R215 27K
R218 2.4K
R219 27K
R221 2.4K
R223 27K
+50V
-50V
-15V
-18V
U202 µL923
U204 µL923
U206 µL923
U208 µL923
FF
CLOCK PULSES FROM Q126
1


TEST SWITCH
PART CLOCK BOARD
CURRENT TRANSFORMER
T251
J251
CW IN
(FREQ RES)
J271
AUX IN
+TRIG OUT
-TRIG OUT
+SIG OUT
-SIG OUT
TO J137
TO J139
TO J185
TO J195
FROM P138
FROM P136
CLOCK
GAIN
STEP RES
FREQ RES
VERT OR HORIZ
AUX IN
TRIGGERING
S265 TEST (MOOG)
GAIN CKT
PULSER CKT
POSITION
AMPLITUDE STEPPED AUX
GANGED WITH R160A,B
4F&R
5F&R
6F&R
1F&R
2F&R



OUTPUT CONNECTORS ④

NOTES

SECTION 6
ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Description	
				CHASSIS	
				Resistors	
Resistors are fixed, composition, ±10% unless otherwise indicated.					
R160A,B,C	311-0948-00			3 x 1 kΩ, Var	
R265	311-0228-00			2 x 10 kΩ, Var	
R273	301-0510-00			51 Ω 1/2 W	5%
				Switches	
	Wired or Unwired				
S106	260-0247-00			Pushbutton DC SHIFT	
S265 Wired	*262-0900-00			Rotary TEST	
S265	260-1171-00			Rotary TEST	
				PULSER Circuit Board Assembly	
	*670-1176-00			Complete Board	
				Capacitors	
Tolerance ±20% unless otherwise indicated.					
C162	281-0151-00			1-3 pF, Var Cer	
C172	281-0151-00			1-3 pF, Var Cer	
C183	281-0064-00			0.25-1.5 pF, Var Tub.	
C193	281-0064-00			0.25-1.5 pF, Var Tub.	

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Description
				Semiconductor Device, Diodes
CR142	152-0141-02			Silicon 1N4152
CR143	152-0141-02			Silicon 1N4152
CR152	152-0141-02			Silicon 1N4152
CR153	152-0141-02			Silicon 1N4152
CR182[1]	152-0442-00			Schotkey barrier
CR183[2]	152-0442-00			Schotkey barrier
CR192[1]	152-0442-00			Schotkey barrier
CR193[2]	152-0442-00			Schotkey barrier
				Connectors
J144	131-0391-00			Coax
J154	131-0391-00			Coax
J180	131-0391-00			Coax
J190	131-0391-00			Coax
				Inductors
L162	276-0543-00			Core, ferrite
L163	276-0543-00			Core, ferrite
L172	276-0543-00			Core, ferrite
L173	276-0543-00			Core, ferrite
LR189	*108-0592-00			1.1 μH (wound on a 820 Ω, 1/4 W, 5% resisto

[1] CR182 and CR192 furnished as a matched pair.

[2] CR183 and CR193 furnished as a matched pair.

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
				Transistors		
Q144	*151-0212-00		Silicon	NPN	TO-18	Tek Spec
Q154	151-0202-00		Silicon	PNP	TO-72	2N4261
Q164	*151-0212-00		Silicon	NPN	TO-18	Tek Spec
Q174	151-0202-00		Silicon	PNP	TO-72	2N4261
				Resistors		
Resistors are fixed, composition, ±10% unless otherwise indicated.						
R142	301-0102-00		1 kΩ	1/2 W		5%
R146	301-0821-00		820 Ω	1/2 W		5%
R147	315-0131-00		130 Ω	1/4 W		5%
R152	301-0102-00		1 kΩ	1/2 W		5%
R156	315-0131-00		130 Ω	1/4 W		5%
R157	301-0821-00		820 Ω	1/2 W		5%
R164	315-0821-00		820 Ω	1/4 W		5%
R174	315-0132-00		1.3 kΩ	1/4 W		5%
R183	317-0510-00		51 Ω	1/8 W		5%
R184	301-0162-00		1.6 kΩ	1/2 W		5%
R187	321-0771-03		50 Ω	1/8 W	Prec	1/4%
R188	317-0471-00		470 Ω	1/8 W		5%
R193	317-0510-00		51 Ω	1/8 W		5%
R194	301-0162-00		1.6 kΩ	1/2 W		5%
R197	321-0771-03		50 Ω	1/8 W	Prec	1/4%
R198	317-0471-00		470 Ω	1/8 W		5%

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
			CLOCK Circuit Board Assembly			
	*670-1177-00			Complete Board		
			Capacitors			
Tolerance ±20% unless otherwise indicated.						
C102	290-0447-00		19 µF	Elect.	20 V	10%
C103	283-0212-00		2 µF	Cer	50 V	
C104	283-0026-00		0.2 µF	Cer	25 V	
C105	283-0004-00		0.02 µF	Cer	150 V	
C106	283-0104-00		0.022 µF	Cer	500 V	5%
C253	281-0122-00		2.5-9 pF,Var	Cer		
C258	281-0122-00		2.5-9 pF,Var	Cer		
C282	283-0178-00		0.1 µF	Cer	100 V	+80%
C284	283-0178-00		0.1 µF	Cer	100 V	-80%
C287	283-0178-00		0.1 µF	Cer	100 V	+80%
C288	283-0110-00		0.005 µF	Cer	150 V	
C289	283-0178-00		0.1 µF	Cer	100 V	+80%
C292	283-0178-00		0.1 µF	Cer	100 V	+80%
C294	283-0178-00		0.1 µF	Cer	100 V	
			Semiconductor Device, Diodes			
VR101	152-0195-00		Zener	1N751A	400 mW, 5.1 V, 5%	
VR102	152-0243-00		Zener	1N965B	400 mW, 15 V, 5%	
VR111	152-0195-00		Zener	1N751A	400 mW, 5.1 V, 5%	
VR112	152-0243-00		Zener	1N965B	400 mW, 15 V, 5%	
CR202	152-0141-02		Silicon	1N4152		
CR204	152-0141-02		Silicon	1N4152		
CR206	152-0141-02		Silicon	1N4152		
CR208	152-0141-02		Silicon	1N4152		
CR212	152-0141-02		Silicon	1N4152		
CR216	152-0141-02		Silicon	1N4152		

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
		Semiconductor Device, Diodes (cont)		
CR220	152-0141-02			Silicon 1N4152
CR224	152-0141-02			Silicon 1N4152
CR228	152-0141-02			Silicon 1N4152
CR229	152-0141-02			Silicon 1N4152
CR274	*152-0185-00			Silicon Replaceable by 1N4152
CR275	*152-0185-00			Silicon Replaceable by 1N4152
CR277	*152-0185-00			Silicon Replaceable by 1N4152
CR278	*152-0185-00			Silicon Replaceable by 1N4152
		Connectors		
J109	131-0391-00			Coax
J119	131-0391-00			Coax
J137	131-0391-00			Coax
J139	131-0391-00			Coax
J185	131-0391-00			Coax
J195	131-0391-00			Coax
J253	131-0391-00			Coax
J258	131-0391-00			Coax
		Inductors		
L142	276-0507-00			Core, ferramic suppressor
L152	276-0507-00			Core, ferramic suppressor
L164	276-0507-00			Core, ferramic suppressor
L174	276-0507-00			Core, ferramic suppressor
LR282	*108-0183-00			1.4 μH (wound on a 43 Ω, 1/2 W, 5% resistor)
LR284	*108-0183-00			1.4 μH (wound on a 43 Ω, 1/2 W, 5% resistor)
LR287	*108-0183-00			1.4 μH (wound on a 43 Ω, 1/2 W, 5% resistor)
LR289	*108-0183-00			1.4 μH (wound on a 43 Ω, 1/2 W, 5% resistor)
LR292	*108-0183-00			1.4 μH (wound on a 43 Ω, 1/2 W, 5% resistor)
LR294	*108-0183-00			1.4 μH (wound on a 43 Ω, 1/2 W, 5% resistor)

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
			Transistors			
Q105	*151-0212-00		Silicon	NPN	TO-18	Tek Spec
Q115	*151-0212-00		Silicon	NPN	TO-18	Tek Spec
Q124	151-0223-00		Silicon	NPN	TO-18	2N4275
Q126	151-0223-00		Silicon	NPN	TO-18	2N4275
Q202	151-0223-00		Silicon	NPN	TO-18	2N4275
Q204	151-0223-00		Silicon	NPN	TO-18	2N4275
Q206	151-0223-00		Silicon	NPN	TO-18	2N4275
Q208	151-0223-00		Silicon	NPN	TO-18	2N4275
Q212	151-0221-00		Silicon	PNP	TO-18	2N4258
Q216	151-0221-00		Silicon	PNP	TO-18	2N4258
Q220	151-0221-00		Silicon	PNP	TO-18	2N4258
Q224	151-0221-00		Silicon	PNP	TO-18	2N4258
			Resistors			
Resistors are fixed, composition, ±10% unless otherwise indicated.						
R101	315-0223-00		22 kΩ	1/4 W		5%
R102	301-0912-00		9.1 kΩ	1/2 W		5%
R108	315-0161-00		160 Ω	1/4 W		5%
R109	315-0151-00		150 Ω	1/4 W		5%
R111	315-0223-00		22 kΩ	1/4 W		5%
R112	301-0912-00		9.1 kΩ	1/2 W		5%
R118	315-0161-00		160 Ω	1/4 W		5%
R119	315-0151-00		150 Ω	1/4 W		5%
R121	315-0221-00		220 Ω	1/4 W		5%
R123	315-0332-00		3.3 kΩ	1/4 W		5%
R125	315-0102-00		1 kΩ	1/4 W		5%
R126	315-0151-00		150 Ω	1/4 W		5%
R128	315-0132-00		1.3 kΩ	1/4 W		5%
R131	301-0102-00		1 kΩ	1/2 W		5%
R132	315-0111-00		110 Ω	1/4 W		5%

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Description		
			Resistors (cont)			
R133	315-0510-00			51 Ω	1/4 W	5%
R136	301-0682-00			6.8 kΩ	1/2 W	5%
R137	315-0241-00			240 Ω	1/4 W	5%
R138	315-0510-00			51 Ω	1/4 W	5%
R165	311-0635-00			1 kΩ, Var		
R201	315-0471-00			470 Ω	1/4 W	5%
R202	308-0562-00			98.8 kΩ	1/4 W WW	1/10%
R203	315-0471-00			470 Ω	1/4 W	5%
R204	308-0562-00			98.8 kΩ	1/4 W WW	1/10%
R205	315-0471-00			470 Ω	1/4 W	5%
R206	308-0563-00			24.625 kΩ	1/4 W WW	1/10%
R207	315-0471-00			470 Ω	1/4 W	5%
R208	308-0563-00			24.625 kΩ	1/4 W WW	1/10%
R210	315-0242-00			2.4 kΩ	1/4 W	5%
R211	315-0273-00			27 kΩ	1/4 W	5%
R212	308-0563-00			24.625 kΩ	1/4 W WW	1/10%
R214	315-0242-00			2.4 kΩ	1/4 W	5%
R215	315-0273-00			27 kΩ	1/4 W	5%
R216	308-0563-00			24.625 kΩ	1/4 W WW	1/10%
R218	315-0242-00			2.4 kΩ	1/4 W	5%
R219	315-0273-00			27 kΩ	1/4 W	5%
R220	308-0562-00			98.8 kΩ	1/4 W WW	1/10%
R222	315-0242-00			2.4 kΩ	1/4 W	5%
R223	315-0273-00			27 kΩ	1/4 W	5%
R224	308-0562-00			98.8 kΩ	1/4 W WW	1/10%

Values are fixed unless marked Variable.

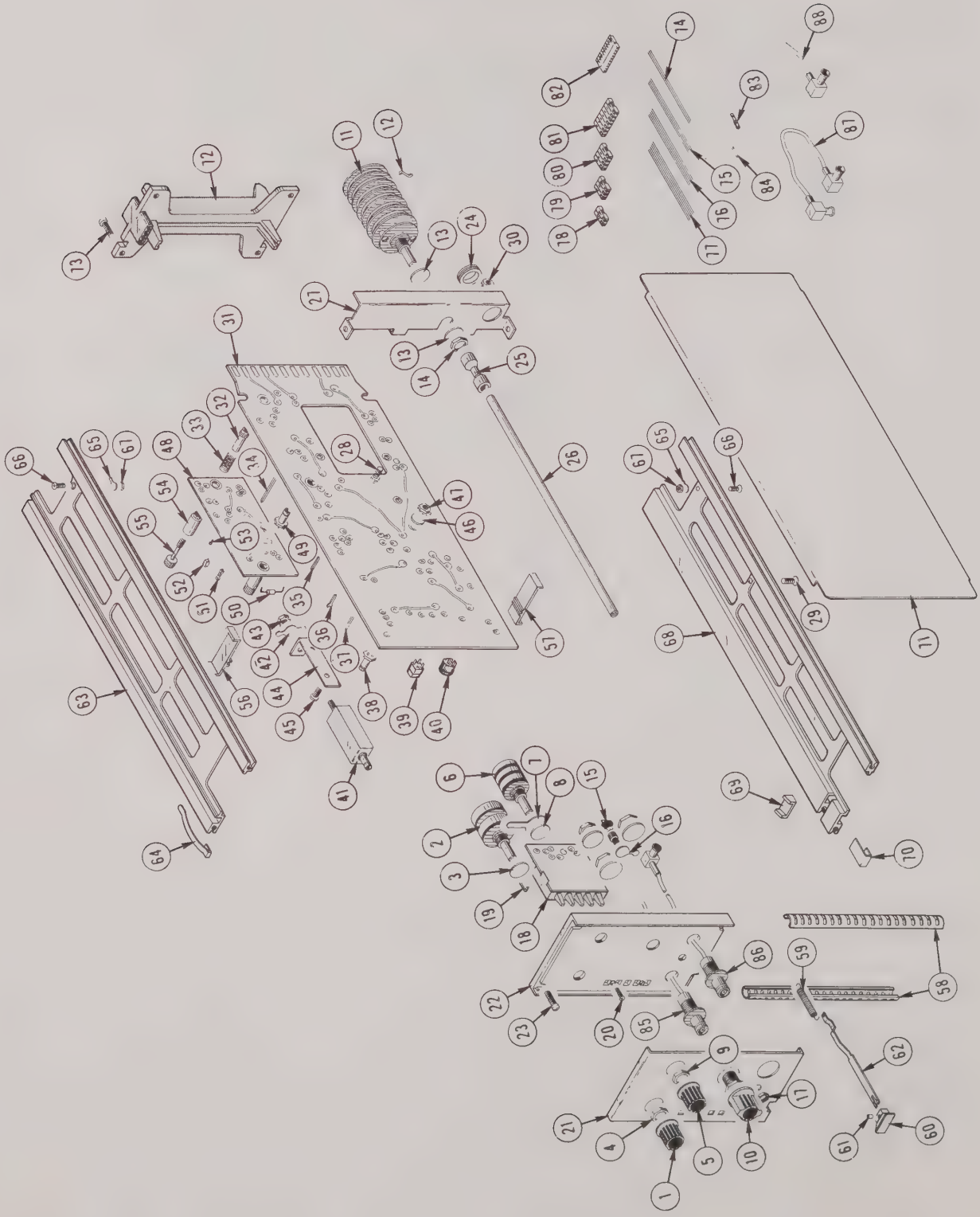
Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Description			
				Resistors (cont)			
R225	315-0683-00			68 kΩ	1/4 W		5%
R226	315-0683-00			68 kΩ	1/4 W		5%
R252	323-0626-00			50 Ω	1/2 W	Prec	1%
R253	315-0680-00	100	265	68 Ω	1/4 W		5%
R253	321-0082-00	266		69.8 Ω	1/8 W	Prec	1%
R254	315-0201-00			200 Ω	1/4 W		5%
R257	323-0626-00			50 Ω	1/2 W	Prec	1%
R258	315-0680-00	100	265	68 Ω	1/4 W		5%
R258	321-0082-00	266		69.8 Ω	1/8 W	Prec	1%
R259	315-0201-00			200 Ω	1/4 W		5%
R261	315-0162-00			1.6 kΩ	1/4 W		5%
R263	315-0162-00			1.6 kΩ	1/4 W		5%
R274	315-0222-00			2.2 kΩ	1/4 W		5%
R275	315-0510-00			51 Ω	1/4 W		5%
R277	315-0222-00			2.2 kΩ	1/4 W		5%
R278	315-0510-00			51 Ω	1/4 W		5%
R281	301-0510-00			51 Ω	1/2 W		5%
R286	301-0470-00			47 Ω	1/2 W		5%
R291	301-0510-00			51 Ω	1/2 W		5%
				Transformer			
T251	*015-0040-00			Transformer, current			
				Integrated Circuits			
U202	156-0012-00			Clocked J-K flip-flop		Replaceable by Fairchild μL923	
U204	156-0012-00			Clocked J-K flip-flop		Replaceable by Fairchild μL923	
U206	156-0012-00			Clocked J-K flip-flop		Replaceable by Fairchild μL923	
U208	156-0012-00			Clocked J-K flip-flop		Replaceable by Fairchild μL923	

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
		REP RATE Circuit Board Assembly		
	*670-1178-01			Complete Board
		Bulb		
DS105	150-0048-01			Incandescent, selected
		Switch		
S105[3]	*670-1178-01			Pushbutton REP RATE

[3] See Mechanical Parts List for replacement parts.

EXPLODED



SECTION 7
MECHANICAL PARTS LIST

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
1-1	366-1024-00			1		KNOB, gray--POSITION
	- - - - - -			-		knob includes:
	213-0153-00			2		SETSCREW, 5-40 x 0.125 inch, HSS
-2	- - - - - -			1		RESISTOR, variable
	- - - - - -			-		mounting hardware: (not included w/resist
-3	210-0012-00			1		WASHER, lock, internal, 0.375 ID x 0.500
	- - - - - -			-		inch OD
-4	210-0590-00			1		NUT, hex., 0.375-32 x 0.438 inch
-5	366-1024-00			1		KNOB, gray--AMPLITUDE STEP or AUX
	- - - - - -			-		knob includes:
	213-0153-00			2		SETSCREW, 5-40 x 0.125 inch, HSS
-6	- - - - - -			1		RESISTOR, variable
	- - - - - -			-		mounting hardware: (not included w/resisto
-7	210-0207-00			1		LUG, solder, 0.375 inch
-8	210-0012-00			1		WASHER, lock, internal, 0.375 ID x 0.500
	- - - - - -			-		inch OD
-9	210-0590-00			1		NUT, hex., 0.375-32 x 0.438 inch
-10	366-1028-00			1		KNOB, gray--TEST
	- - - - - -			-		knob includes:
	213-0153-00			2		SETSCREW, 5-40 x 0.125 inch, HSS
-11	262-0900-00			1		SWITCH, rotary--VERT or HORIZ TRIGGERING,
	- - - - - -			-		wired
	- - - - - -			-		switch includes:
	260-1131-00			1		SWITCH, rotary, unwired
-12	195-0071-00			2		LEAD, electrical
	- - - - - -			-		mounting hardware: (not included w/switch
-13	210-0978-00			2		WASHER, flat, 0.375 ID x 0.500 inch OD
-14	210-0413-00			1		NUT, hex., 0.375-32 x 0.500 inch
-15	260-0247-00			1		SWITCH, push-button--DC SHIFT
	- - - - - -			-		mounting hardware: (not included w/switch
-16	210-0223-00			1		LUG, solder, 0.250 ID x 0.437 inch OD, SE
-17	210-0583-00			1		NUT, hex., 0.250-32 x 0.312 inch
-18	670-1178-01			1		CIRCUIT BOARD ASSEMBLY--REP RATE
	- - - - - -			-		circuit board assembly includes:
-19	131-0589-00			9		TERMINAL, pin, 0.500 inch long
	380-0156-00			1		HOUSING, light
	- - - - - -			-		mounting hardware: (not included w/housin
	213-0181-00			1		SCREW, thread forming, #2 x 0.375, PHS
	- - - - - -			-		mounting hardware: (not included w/assembly
-20	211-0156-00			2		SCREW, 1-72 x 0.250 inch, 82° csk, FHS

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
-21	333-1286-00			1		PANEL, front
-22	386-1447-26			1		SUBPANEL, front
	- - - - - -			-		mounting hardware: (not included w/subpanel)
-23	213-0192-00			4		SCREW, thread forming, 6-32 x 0.500 inch, Fil HS
	- - - - - -			-		
-24	348-0005-00			1		GROMMET, rubber, 0.500 inch diameter
-25	376-0011-00			1		COUPLING, plastic
	- - - - - -			-		coupling includes:
	213-0048-00			2		SETSCREW, 4-40 x 0.125 inch, HSS
-26	384-0090-00			1		SHAFT, extension, 7.938 inches long
-27	407-0738-00			1		BRACKET, switch
	- - - - - -			-		mounting hardware: (not included w/bracket)
-28	211-0116-00			2		SCREW, sems, 4-40 x 0.312 inch, PHB
-29	211-0101-00			2		SCREW, 4-40 x 0.250, 100° csk, FHS
-30	210-0586-00			4		NUT, keps, 4-40 x 0.250 inch
-31	670-1177-00			1		CIRCUIT BOARD ASSEMBLY--CLOCK
	- - - - - -			-		circuit board assembly includes:
	388-1491-00			1		CIRCUIT BOARD
-32	351-0184-00			2		GUIDE-POST, lock
-33	214-1140-00			2		SPRING, helical compression
-34	131-0665-00			4		TERMINAL, pin, 0.880 inch long
-35	131-0590-00			2		TERMINAL, pin, 0.665 inch long
-36	131-0525-00			2		TERMINAL, stud, 0.449 inch long
-37	131-0589-00			34		TERMINAL, pin, 0.500 inch long
-38	131-0391-00			8		CONNECTOR, coaxial, male
-39	136-0220-00			12		SOCKET, transistor, 3 pin, square
-40	136-0237-00			4		SOCKET, semiconductor device, 8 contact
-41	015-0040-00			1		TRANSFORMER, current
	- - - - - -			-		mounting hardware: (not included
	- - - - - -			-		w/transformer)
-42	210-0204-00			1		LUG, solder, DE #6
-43	210-0457-00			1		NUT, keps, 6-32 x 0.312 inch
-44	407-0739-00			1		BRACKET
	- - - - - -			-		mounting hardware: (not included
	- - - - - -			-		w/bracket)
-45	211-0009-00			2		SCREW, 4-40 x 0.250 inch, OHS
-46	210-1001-00			2		WASHER, flat, 0.119 ID x 0.375 inch OD
-47	210-0586-00			2		NUT, keps, 4-40 x 0.250 inch
-48	670-1176-00			1		CIRCUIT BOARD ASSEMBLY--PULSER
	- - - - - -			-		circuit board assembly includes:
	388-1490-00			1		CIRCUIT BOARD
-49	131-0391-00			4		CONNECTOR, coaxial, male
-50	131-0566-00			2		LINK, terminal connecting
-51	136-0263-03			6		SOCKET, pin terminal
-52	344-0108-00			8		CLIP, diode
-53	136-0252-01			16		SOCKET, pin connecting Ⓐ

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
-54	361-0238-00			2		SPACER, sleeve
	- - - - - -			-		mounting hardware: (not included w/assembly
-55	211-0155-00			2		SCREW, 4-40 x 0.375 inch, knurled
-56	344-0210-00			2		CLIP, circuit board, top
-57	344-0211-00			2		CLIP, circuit board, bottom
-58	348-0235-00			2		SHIELDING GASKET
-59	214-1280-00			1		SPRING, helical compression
-60	366-1058-00			1		KNOB, gray, latch
-61	214-1095-00			1		PIN, spring, split
-62	105-0076-00			1		RELEASE BAR, latch
-63	426-0505-10			1		FRAME-SECTION, top
-64	214-1061-00			1		SPRING, flat, sliding ground
-65	210-0259-00			2		LUG, solder, #2
	- - - - - -			-		mounting hardware: (not included w/lug)
-66	211-0030-00			2		SCREW, 2-56 x 0.250 inch, 82° csk, FHS
-67	210-0405-00			2		NUT, hex., 2-56 x 0.187 inch
-68	426-0499-10			1		FRAME-SECTION, bottom
-69	105-0075-00			1		BOLT, latch
-70	214-1054-00			1		SPRING, flat, latch detent
-71	337-1064-00			2		SHIELD
-72	386-1402-00			1		PANEL, rear
	- - - - - -			-		mounting hardware: (not included w/panel)
-73	213-0192-00			4		SCREW, thread forming, 6-32 x 0.500, Fil HS
-74	175-0825-00			ft		WIRE, electrical, 2 wire ribbon, 8.375
	- - - - - -			-		inches long
-75	175-0826-00			ft		WIRE, electrical, 3 wire ribbon, 4.500
	- - - - - -			-		inches long
-76	175-0827-00			ft		WIRE, electrical, 4 wire, ribbon, 13.750
	- - - - - -			-		inches long
-77	175-0828-00			ft		WIRE, electrical, 5 wire ribbon, 14.875
	- - - - - -			-		inches long
-78	352-0198-00			10		HOLDER, terminal connector, 2 wire
-79	352-0199-00			2		HOLDER, terminal connector, 3 wire
-80	352-0200-00			1		HOLDER, terminal connector, 4 wire
-81	352-0203-00			1		HOLDER, terminal connector, 7 wire
-82	352-0168-00			1		HOLDER, terminal connector, 10 wire
-83	131-0621-00			31		CONNECTOR, terminal (for small wire)
	131-0622-00			7		CONNECTOR, terminal (for large wire)
-84	131-0707-00			9		CONNECTOR, terminal
-85	175-1134-00			1		CABLE ASSEMBLY, 5.000 inches long
-86	175-1133-00			1		CABLE ASSEMBLY, 8.125 inches long
-87	175-1136-00			2		CABLE ASSEMBLY, 8.000 inches long
-88	131-0375-00			8		CONNECTOR, right angle, 50 Ω, female

STANDARD ACCESSORIES

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
	062-1128-00			1		Manual, instruction (not shown)

067-0587-00 EFF SN B040000-up

ELECTRICAL PART LIST CORRECTIONS

*670-1176-00 COMPLETE BOARD

CHANGE TO:

R188	317-0301-00	300 Ω, 1/8 W, 5%
R198	317-0301-00	300 Ω, 1/8 W, 5%

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